GAS!

KNOW YOUR CHEMICAL WARFARE

REVISED AND ENLARGED JUNE 1945

BUREAU OF NAVAL PERSONNEL, WASHINGTON 25, D. C. NAVPERS 15039

U.S. Bureau of Naval Personnel

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CHEMICAL WARFARE REFERENCE CHART

Tactical classification	Physiological classification	Symbol	Name	Odor	Color and state	Persistency	Protection
CASUALTY AGENTS (Green labels)	Blister Gases (Vesicants)	H	Mustard	Garlic, horseradish, mustard.	Light to dark brown oily liquid or colorless gas.	1 day to all winter	Gas mask, protective clothing, protective cover, eye shield, protective ointment S–461 or S–330.
		HN	Nitrogen Mustards	Faint fishy odor	Colorless to pale yellow liquid or colorless gas.	2 hours to days	Do.
		L	Lewisite	Geraniums	Light to dark brown oily liquid or colorless gas.	1 day to 1 week	Do.
		ED	Ethyldichlorarsine	Faint fruity odor, biting in high concentrations.	Colorless or brown liquid or colorless gas.	1 to 12 hours	Do.
	Choking Gases (Lung Irritants)	CG	Phosgene	Hay, green corn, silage	Colorless gas	1 to 10 minutes	Gas mask.
		DP	Diphosgene	Do	Yellow liquid or colorless gas.	15 minutes to 3 hours	Do.
		PS	Chlorpicrin	Fly paper	Colorless liquid or gas	1 hour to 1 week	Do.
	Blood and Nerve Poisons	AC	Hydrocyanic Acid	Almond flavoring or peach kernels.	Colorless liquid or gas	5 minutes to 1 hour	Do.
		CK	Cyanogen Chloride	Pungent, irritating	Do	10 minutes to 2 hours	Do.
		SA	Arsine	Faint garlic-like odor	Colorless gas	1 to 10 minutes	Do.
HARASSING AGENTS (Red labels)	Vomiting Gases (Irritant Smokes)	DM	Adamsite	Irritating, coal smoke	Yellow smoke	10 minutes	Do.
		DA	Diphenylchlorarsine	Irritating, shoe polish	White or grey smoke	5 to 10 minutes	Do.
		DC	Diphenylcyanarsine	Irritating, garlic, or almond flavoring.	White smoke	Do	Do.
	Tear Gases (Lacrimators)	CN	Chloracetophenone	Apple blossoms	Cloud of particles or colorless gas.	10 minutes to weeks	Do.
		CNS	Chloracetophenone Solution	Fly paper	Cloud of droplets or colorless gas.	1 hour to 1 week	Do.
		CNB	Chloracetophenone Training Solution.	Benzene	Do	Not determined	Do.
		BBC	Brombenzylcyanide	Sour fruit	Solid, liquid, or colorless gas	Days to weeks	Do.
SCREENING SMOKES (Yellow labels)		HC	Hexachlorethane Mixture	Sharp, stinging	White to grey smoke	While burning	Mask in high concentration.
		FS	Sulphur Trioxide in Chlorsulfonic Acid.	Do	Dense, white smoke	5 to 10 minutes	Do.
		FM	Titanium Tetrachloride	Do	White smoke	1 to 10 minutes	Do.
		WP	White Phosphorus	Burning matches	Burns to white smoke in air	Do	Do.
INCENDIARIES (Purple labels)		TH	Thermit	None	White-hot metal	While burning	None.
		TH	Magnesium	Do	Burns brilliant white light	Do	Do.
		IM, NP	Thickened Gasoline	Burning oil	Pale yellow jelly. Burns with yellow smoky flame.	Do	Do.

Do not rely on odors alone for identification of gases. *When in doubt don the mask.* Persistency varies markedly with weather, terrain, and method of spread. The symbols H, L, CK, BBC, formerly HS, M–1, CC, CA, respectively.

SELF-AID REFERENCE CHART

Agent	Symbol	Symptoms	Self-aid
BLISTER GASES or MIXED BLISTER GASES	H	No immediate symptoms. 30 minutes to 36 hours later irritation of eyes; itching, redness, and blistering of skin; coughing, hoarseness, and vomiting.	*EYES*—All contaminations of the eyes by any liquid blister gas are decontaminated by one standard procedure: Ointment BAL into the eye or lower lid, massage for 1 minute, wash out with water for 30 seconds to 2 minutes. *SKIN*—Blot off, not rub, all liquid with absorbent or dry cloth which should be destroyed later. Rub in protective ointment S–330 or S–461 for about 15 seconds. Wipe off excess. Large areas, reapply and remove. Then rub in ointment BAL and allow to remain for 5 minutes and reapply. Wash with soap and warm water as soon as possible. Do not use protective ointments on reddened skin. Do not use protective ointments S–461 or S–330 in the eyes. *CAUTION:* Liquid vaporizes from the skin, clothing, equipment, and any other objects. Therefore, turn face away and breathe as little as possible until the eyes and face are decontaminated and the gas mask donned. Remove contaminated clothing and treat underlying skin. Clothing must be discarded or decontaminated so poisonous fumes will not contact other men.
	HN	During or shortly after exposure, eyes are affected so that vision is seriously decreased. Later effects on eyes and skin similar to mustard.	
	L	Immediate stinging and pain of eyes and skin. Redness and blistering of the skin appear quickly. Irritates nose, throat, and lungs and causes sneezing, coughing and chest pain. Nausea and vomiting often prominent.	
	ED	Same as Lewisite.	
CHOKING GASES	CG DP	Coughing, choking, and flow of tears. Later, difficulty in breathing and pain in chest.	Protect from further exposure by immediate donning of mask. No other self-aid necessary unless breathing becomes difficult. In that event keep quiet and warm until given medical attention.
	PS	Irritation of eyes and flow of tears. Pain in chest, coughing, and choking. Severe exposure causes nausea and vomiting. Later, difficulty in breathing.	
BLOOD AND NERVE POISONS	AC CK SA	Giddiness, headache, twitching, convulsions, and unconsciousness. CK also causes irritation of eyes, nose, and throat, coughing and tightness across chest.	Immediately don mask. If conscious and breathing, no further treatment is necessary. If casualty is unconscious, but breathing: Crush 2 pearls of amyl nitrite and place under the mask; if not breathing give artificial respiration in addition. Later, if breathing becomes difficult, keep quiet and warm until given medical attention.
VOMITING GASES	DM DA DC	Irritation of eyes, nose, and throat. Vomiting, severe frontal headache, and temporary mental depression follow.	Immediately don mask. Loosen clothing. Sniff chloroform. Additional self-aid usually not necessary. *CAUTION:* Do not lift mask from face except when vomiting.
TEAR GASES	CN CNS CNB BBC	Irritation and watering of eyes forcing closure of lids, burning of exposed skin areas. Heavy exposure causes irritation of the nose, throat, and lungs, and produces nausea and vomiting.	Immediately don mask. Do not rub eyes. Face upwind if unmasked. If eyes and skin burn, wash with water. Additional self-aid usually not necessary.

SELF-AID IS THE INDIVIDUAL RESPONSIBILITY OF ALL HANDS. CARE FOR YOURSELF INSTANTLY ON EXPOSURE. SPEED IS ESSENTIAL. EACH SECOND LOST INCREASES THE FINAL DAMAGE.

SELF-AID REFERENCE CHART—Continued

Agent	Spmbol	Symptoms	Self-aid
SCREENING SMOKES	HC FS FM WP	Heavy concentrations irritate eyes, nose, and throat. Liquid FS and liquid FM produce acid burns. Particles of phosphorus produce heat burns.	If smoke is irritating, don mask. If eyes and skin burn, wash with water. If breathing becomes difficult, keep quiet and warm until given medical attention. The possibility of smoke screening poisonous gases must be kept in mind. White phosphorous particles must be kept wet until removed. Immerse in water or cover burn with a cloth soaked with water. Where available, a solution of copper sulfate should be used instead of water. Do not use grease or salve.
INCENDIARIES	TH (Magnesium) TH (Thermit) IM NP	Heat burns.	Cool the burning material by flooding with water and remove. Treat the burn like any other heat burn.

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PREFACE

By means of this pamphlet the individual can learn how to take care of himself in any gas attack. This pamphlet contains six lectures in Chemical Warfare covering the rudiments of gas identification, personal protection, matériel and tactics, and decontamination.

Using discussion, line drawings, and charts, the pamphlet presents the important principles of defense; and briefly, offensive measures in Chemical Warfare.

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I

CHEMICAL WARFARE AGENTS

Introduction—The use of war gases against the Navy is a constant threat which must be recognized and prepared for by all hands. No area, whether land or sea, within the range of enemy aircraft can be considered safe from such attacks. Our enemy is known to have made extensive preparations for chemical warfare. We must be ready to meet them.

War gases used against untrained men would cause many casualties and might create a panic. Against men properly trained and equipped, however, gas is simply another weapon to be overcome. Defense against chemical attack is based on the *individual's* being able to *protect himself* so that he can carry on in spite of it.

If a person is to understand chemical warfare clearly, it is essential that he have a thorough knowledge of the chemical agents that may be employed. We want you to have a respect for, but not a fear of chemical warfare.

"Chemical warfare agents" are substances useful in war which, through their ordinary chemical properties, have a toxic or irritant effect on the body, or produce a screening smoke, or incendiary action. What we in the Navy are chiefly concerned with in chemical warfare are those agents which produce a powerful physiological effect on contact with the body.

Classification of agents

Agents may be considered from two general standpoints:

1. **Tactical**—or the way the agents are used in the field.
2. **Physiological**—or the effect the agents have on the body.

Agents are classified *tactically* as follows:

A. *Casualty agents*—designated on munitions by green bands.
B. *Harassing agents*—designated by red bands.
C. *Screening smokes*—designated by yellow bands.
D. *Incendiary agents*—designated by purple bands.

Casualty agents are those agents of such chemical and physical characteristics that a dangerous or killing concentration can be set up under ordinary field conditions or aboard ship. These include the blister gases, choking gases, and the blood and nerve poisons.

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Harassing agents are those agents used primarily to force masking and thereby interfere with military operations. They include the tear gases and vomiting gases.

Screening smokes are substances which, when burned or otherwise released in air, produce a dense, obscuring smoke.

Incendiaries are agents which generate sufficient heat to set fire to combustible substances.

Agents are classified *physiologically* as follows:

Blister gases (*vesicants*) are chemical warfare agents which are readily absorbed by both the exterior and the interior parts of the human body, resulting in inflammation, burns, blisters, and general destruction of tissue. They are irritating both as liquids and vapors.

Choking gases (*lung irritants*) are chemical warfare agents which, when breathed, cause inflammation and irritation of the nose, throat, windpipe, and lungs.

Blood and nerve poisons (*systemic poisons*) are chemical warfare agents which are taken up by the blood, interfere with the absorption and distribution of oxygen, and act primarily upon nerve centers affecting breathing and heart action, and injure other organs.

Vomiting gases (*irritant smokes*) are chemical warfare agents which, when breathed even in extremely low concentrations, cause coughing, sneezing, headache, pain in the nose and about the teeth, followed by nausea, vomiting, and temporary physical weakness.

Tear gases (*lacrimators*) are chemical warfare agents which cause temporary intense eye pain and produce a heavy flow of tears. They may also irritate the skin.

History of war gases

Choking gases

Chlorine.—Here is a very brief history of the development of war gases. The choking gas *chlorine* (Cl) was the first war gas used during World War I. It was introduced by the Germans against the Allies on April 22, 1915. Although warned by the Germans of the coming poison gas attack, the Allies were caught by surprise and suffered heavily. Of the 20,000 casualties, 5,000 proved fatal. Later in the war, when troops were protected with gas masks, the effectiveness of chlorine was greatly reduced. Today chlorine, which is a heavy greenish-yellow gas, is not considered a good war gas because of its low toxicity. It is now used primarily in the manufacture of other war gases.

Phosgene and diphosgene.—The only American gas used in American munitions during the last war was *phosgene* (CG). Phosgene is also a choking gas, and has an odor which is described variously as that of silage, green corn, or hay. It is 9 to 10 times more toxic than

chlorine, affecting the lower part of the lungs rather than the upper part of the respiratory tract. Another choking gas, *diphosgene* (DP), is more persistent than phosgene, and was favored by the Germans. The Germans used this gas in the last war and were reported to have had a large supply on hand in this one.

Chlorpicrin.—Still another choking gas is *chlorpicrin* (PS). This agent, in addition to its choking action, causes some lacrimation, nausea, and vomiting. For this reason, it has often been called "puke stuff." Pure chlorpicrin is a nearly colorless liquid differing little from water in appearance, although slightly oily. The odor is sweetish and resembles that of fly paper. Although chlorpicrin is considerably more persistent than phosgene, it is less toxic.

Vomiting gases

Diphenylchlorarsine, Adamsite, and diphenylcyanarsine.—By the summer of 1917, the gas masks of the belligerents had been developed to such a degree that they furnished adequate protection against the choking gases. The choking gases employed during the war were slow in acting, and did not incapacitate until several hours after exposure. The problem was, therefore, to find a quick-acting, more persistent gas that would penetrate the masks. The vomiting gas, *diphenylchlorarsine* (DA), was the German solution. Diphenylchlorarsine was dispersed in the form of a fine dust which was not readily absorbed by the charcoal in the gas mask canister. When these dust particles, which had an odor like shoe polish, were inhaled, they caused sneezing, followed by violent headaches, nausea, vomiting and physical weakness. While this irritant smoke produced few serious casualties, its most damaging effect was indirect. The soldier became nauseated and was forced to vomit. If he removed his mask, he fell victim to other more lethal gases which were released simultaneously.

Another vomiting gas is *Adamsite* (DM). This agent is chemically known as diphenylaminechlorarsine. Adamsite, when pure, is a bright canary-colored, crystalline solid and practically odorless. When dispersed as a smoke, it forms a bright yellow cloud with an odor of coal smoke. *Dyphenylcyanarsine* (DC) is the vomiting gas which the Japanese are reported to favor. DC smoke is white and smells like garlic and almond flavoring. The effects of both DM and DC are like those of DA.

Blister gases

With the addition of a mechanical filter to remove such toxic particles from the contaminated air, the gas mask provided adequate protection against the vomiting gases as well as the choking gases. Therefore, some agent against which the mask alone would not give sufficient protection was desired. This was found to be *mustard* gas

(H), which, during World War I, became the most important chemical warfare agent because of the difficulty of protecting against it. Mustard gas and the other blister gases attack any part of the body with which the vapor or liquid comes in contact, causing serious burns and blisters. There is no pain connected with the initial exposure to mustard, and symptoms may be delayed from ½ to 36 hours. This type of agent is thus insidious in its action and extremely difficult to guard against, since the ordinary uniform affords little, if any, protection. For further protection against blister gases in the present war, special types of protective clothing have been designed, which are available to all exposed personnel aboard ships and to all personnel at advanced bases. In addition, individual protective covers for protection against blister gas spray are included as part of the regular protective equipment for shore-based personnel.

Mustard gas is not only a strong blister gas, but also a powerful choking gas which attacks the whole respiratory system. This "Hun Stuff" or "Hot Stuff" as it was called by the troops in the last war, is a heavy, dark, oily liquid and has an odor similar to that of garlic or horseradish. It freezes at a relatively high temperature (46°–50° F.), which prohibits its being sprayed from high altitudes or in cold climates. However, mixed with Lewisite, another blister gas, the freezing point of the mixture is considerably lower than that of mustard, and the mixture can be sprayed under nearly all conditions. This method of disseminating blister gases has been found to be very effective and will undoubtedly be used should chemical warfare break out.

While *Lewisite* (L) is not as persistent as mustard, it possesses several outstanding characteristics. Lewisite causes immediate pain of the eyes and skin. In addition, arsenic poisoning may result from absorption of Lewisite. Lewisite is an oily light to dark brown liquid and has an odor of geraniums. It freezes at 0° F., and since water readily destroys the blistering properties of liquid Lewisite, the chief usefulness of this agent is under conditions that minimize hydrolysis; that is, in cold weather or in hot, dry areas. Nevertheless, contaminated areas may remain dangerous for long periods, as one of the hydrolysis products, Lewisite-oxide, is a solid blister agent, and very toxic. However, since it does not evaporate, there is little danger of getting burned unless the skin comes in direct contact with the Lewisite-oxide.

A blister gas which was used to a slight extent in the last war was *ethyldichlorarsine* (ED). Like Lewisite, it contains arsenic and its effects on the body are similar. This agent is not only less persistent than either mustard or Lewisite, but also less blistering in its action. It is recognized in the field by its stinging or biting odor.

Nitrogen mustards.—Up to the present time, the presence of war gases could be detected by their characteristic odors. Now, however, very potent blister gases have been developed which have little or no odor even when present in high concentrations. These agents are the *nitrogen mustards* (HN), and their vapors are particularly blistering in their action. During or shortly after exposure even to low concentrations, they so affect the eye that vision is seriously decreased. The relatively faint odor is described as "fishy."

Blood and nerve poisons

Hydrocyanic acid (AC), a typical blood and nerve poison, had a very limited use in World War I, but has definite future possibilities in this war. It causes collapse and unconsciousness from systemic poisoning. AC is a colorless liquid that quickly vaporizes. Its odor in field concentrations is similar to peach kernels or almond flavoring. SPEED CANNOT BE STRESSED TOO MUCH IN THE PROTECTION AND TREATMENT FOR THIS GAS AS IT KILLS IN A MATTER OF SECONDS BY CAUSING A RAPID FAILURE IN BREATHING.

Cyanogen chloride (CK), is a clear, colorless liquid even more volatile than AC. It has a pungent odor, irritates the nose and throat and causes a flow of tears even in low concentrations. As with AC, SPEED IS ABSOLUTELY ESSENTIAL in treating it, as it causes death in the same way.

Arsine (SA), the third blood and nerve poison, is odorless in a pure state and is therefore particularly dangerous. If impure, it may smell faintly of garlic. ALTHOUGH SPEED IN PROTECTING AGAINST IT IS AS ESSENTIAL AS WITH AC OR CK in that a very small amount of the gas may cause death, its reaction in the blood is often delayed. It destroys the red blood cells and damages the liver, kidneys, and spleen.

Tear gases

Although tear gases were used throughout the first World War, their employment became more and more limited as other more powerful gases were introduced. However, owing to their effectiveness in low concentrations, tear gases served a useful purpose by forcing troops to mask. The principal tear gases now in use are *chloracetophenone* (CN), a solid, and its two solutions, CNB and CNS. CNB, which is a mixture of chloracetophenone, benzene, and carbon tetrachloride, is used primarily in training troops. CNS, which is a mixture of chloracetophenone, chlorpicrin, and chloroform, because of its greater lacrimatory, choking and skin effects, would probably be employed if chemical warfare breaks out. The use of solid chloracetophenone in armor-piercing shells against ships at sea appears very

probable, since this would tend to hinder any repair parties that might be at work.

Brombenzylcyanide (BBC) is a tear gas which is used and favored by the British. Its chief disadvantages are corrosive action and the expense involved in manufacture.

Screening smokes

There are many ways of dispersing smoke, depending upon the nature of the material. Smoke may be generated by combustion or heating of the agent, or by spraying into the air. The smoke mixture normally used is *sulfur trioxide* in *chlorsulfonic acid* (FS). This is carried aboard certain types of ships in two generators, one port and one starboard, at the stern. Each generator consists of four tanks, each tank containing 32 gallons of the FS mixture. FS is released by air pressure, and on combining with the moisture in the atmosphere, produces a white smoke. FS is used instead of another smoke, FM (*titanium tetrachloride*) for several reasons. Among other things, the cost is less than that of FM, and the obscuring power is somewhat better. HC smoke pots are a different type of smoke munition utilized by the Navy. They are made in two designs, floating and nonfloating, and may be used on shore installations or dropped off vessels into the water at sea to set up a shielding smoke screen. The smoke is produced by the burning of a mixture of solid chemicals. Fog oil smoke produced by vaporizing a special type of oil with steam under high pressure is now being used extensively in operations both ashore and afloat.

White phosphorus (WP) is a good smoke-producing agent and is also a fair incendiary and good casualty agent. WP in explosive shells or air bombs has some incendiary effect against grass, woods, and buildings of light wood structure. However, a WP fire is easily extinguished through the use of water, although the WP will reignite as soon as the water evaporates.

Incendiaries

For materials which require higher temperature to ignite, special incendiary agents are employed. The three main incendiaries in use now are *magnesium* (TH), *thermit* (TH) and thickened gasoline (IM or NP). A magnesium bomb burns at a temperature of 3,630° F., and the addition of water only tends to increase the intensity of the fire, since it supplies oxygen. This type of bomb burns from 10 to 15 minutes. During combustion, the hot molten magnesium spatters, spreading the fire.

The thermit bomb is not often encountered because used alone as an incendiary it has limited value due to the small area covered by the charge. The thermit bomb is merely a steel container of thermite,

which is iron oxide and aluminum, and burns at a temperature of 4,300° F. This temperature is sufficient to melt through iron or steel and ignite any combustible materials in the vicinity, but it does not spread out over a wide area, and burns for only a very brief period of time. One of its main uses is in the destruction of field artillery and equipment to prevent its being captured intact by the enemy.

Summary

For a quick summary, let us review the physiological classification of the principal chemical warfare agents. First are the choking gases: chlorine (Cl), phosgene (CG), diphosgene (DP), chlorpicrin (PS). Of these, phosgene, diphosgene, and chlorpicrin are the most important. Second come the vomiting gases: diphenylchlorarsine (DA), Adamsite (DM), and diphenylcyanarsine (DC) being the most widely used. The blister gases are those agents against which the gas mask alone does not give adequate protection because parts of the body other than face, eyes, and lungs may be affected. The important blister gases are mustard (H), nitrogen mustards (HN), Lewisite (L), and to a lesser extent, ethyldichlorarsine (ED). Blood and nerve poisons are likely to become with the blister gases the most dangerous of chemical warfare agents. At present they include hydrocyanic acid (AC), cyanogen chloride (CK) and arsine (SA). The chief tear gases are chloracetophenone (CN), and its two solution forms, CNS and CNB. The British tear gas is brombenzylcyanide (BBC). The screening smokes used are HC (a solid), FS and FM (both liquids), white phosphorus (WP), and fog oil. The principal incendiary agents are magnesium (TH), thermit (TH), and thickened gasoline (IM or NP).

There are other chemical warfare agents that may be used, and more are being developed each year, but the above list gives the most important ones for each classification, and should furnish an adequate introduction to the type of agents employed in chemical warfare.

II

SELF-AID

Defense against gas

Good gas defense demands fearless action, the best possible use of protective equipment, and prompt self-aid. Our gas injuries in the last war required a total of 2,947,199 days' hospitalization. In other words, the equivalent of almost 100,000 men were unable to fight for a whole month. Such a circumstance might have meant the loss of an important battle. As the last war progressed, however, gas protection improved, gas discipline became routine, self-aid was taught each man, and the number of injured decreased.

If we are able to answer the following questions, we know the basic principles of defense against chemical warfare:

DO I KNOW HOW TO USE MY PROTECTIVE EQUIPMENT?

DO I KNOW ENOUGH ABOUT SELF-AID SO THAT I CAN TREAT MYSELF IF CONTAMINATED BY GAS?

Our equipment, as good as any in existence, has been tested against every known war gas. It has been tried in cold, dry climates, in hot, wet weather, in rain and snow, and under conditions similar to those of battle. The gas mask not only protects the eyes and face, but also removes gas from the air we breathe, preventing injury to the nose, mouth, throat, and lungs. Protective clothing and ointments prevent blister gases from reaching the skin, where they may produce burns and blisters. The object of our antigas training is to enable us to use this equipment for the best protection. It also acquaints us with the effects of the various gases on our body and teaches us what to do for ourselves when we are exposed to them.

Self-aid for blister gases

Blister gases injure the eyes, burn and blister the skin, and when inhaled, damage the nose, throat, windpipe, and lungs. When absorbed by the body they are poisonous. The most important are *mustard* (H), *nitrogen mustards* (HN), *Lewisite* (L) and mixtures of blister gases.

These gases are injurious either as vapors or as liquids. They can penetrate uniforms, boots, shoes, or any other objects not specially

treated to make them gasproof. Blister gas liquids evaporate and produce fumes which are poisonous. Thus, contaminated men can carry and spread the gas to other men and places. The wind blowing across contaminated areas carries the poisonous fumes which affect men downwind.

Specific routine of personal decontamination, or self-aid, must be accomplished at once if serious eye and skin damage is to be prevented after contamination by liquid blister gases. *This is the individual responsibility of all hands.* Personnel serving guns and engaged in other active combat measures shall not interrupt their work during an engagement to apply self-aid but shall do so at the *earliest possible moment.*

An individual at the time of the gas attack, whether it be by airplane spray, shell or bomb burst, may be unable to decide the exact nature of the agent because mixtures of gases may be used, or smoke may be employed to mask characteristic odors. The hazard of encountering any one blister gas by itself appears small. In the self-aid procedure given below, the individual does not have to distinguish between the different blister gases. He shall carry out the following procedure when contaminated with *any* liquid blister gas unless directed otherwise by local authority.

Decontamination procedure—Eyes

All contamination of the eyes with liquid blister gases, whether they be mustard, nitrogen mustard, Lewisite, or a mixture, is treated by *one standard procedure:*

(*a*) Immediately after contamination by any liquid blister gas, ointment BAL is squeezed directly into the lower eyelid. If the eye cannot be opened because of pain, the ointment is applied to the eyelids and rubbed in well, especially to the slit between the lids. Sufficient ointment will enter between the lids to relieve the pain and swelling to such an extent as to make it possible to open the eye. More ointment is then placed directly into the lower eyelid.

(*b*) The lids are then closed and massaged for 1 minute.

(*c*) This is followed by washing out the eye with water from a canteen or any other available uncontaminated source. The head is thrown back, the lids are forced open with the fingers of one hand while the water is poured into the eye from a canteen in the other hand. The eye should be washed with water for at least half a minute and no longer than 2 minutes. (If ointment BAL is not instantly available, the eye shall be washed with water immediately.)

Ointment BAL itself causes a stinging pain and a flow of tears in an uncontaminated eye or in an eye contaminated by any of the blister gases other than Lewisite and the arsenicals. This pain lasts for about

20 minutes. Even so, ointment BAL lessens the pain due to Lewisite, stops the damaging action of the blister gases, and saves the eye. Therefore, it is to be used when any liquid blister gas gets in the eyes. This holds true in spite of the fact that the printing on the tube states that ointment BAL is used only for Lewisite.

If your eyes become contaminated with Lewisite or any mixture containing Lewisite, they will be clamped tightly shut because of pain and swelling, and you must learn to apply BAL to the eye by feel alone. *Therefore, it is most important for you to be able to tell by feel alone the difference between the tubes of BAL, S–461, and S–330.* Remember the BAL tube is the smaller. Also remember where in your gas mask carrier it is placed. *Protective ointments S–461 and S–330 must never be put in the eyes.*

Decontamination procedure—Skin

Any liquid blister gas on the skin is treated in the following manner:

(*a*) The liquid blister gas is blotted from the skin with the absorbent cloth wrapped around each tube of protective ointment S–461 or S–330 or by any absorbent material at hand. A clean portion of the cloth should be used for each drop of liquid in order to avoid spreading the contamination. *Discard the used absorbent.* The S–461 or S–330 ointment is then freely applied to the area and rubbed in with the fingers for 15 seconds. The excess is immediately removed. For large areas more protective ointment is applied, rubbed in, and wiped off.

(*b*) Ointment BAL is then spread on the skin in a thin film, rubbed in with the fingers, and allowed to remain at least 5 minutes and reapplied.

(*c*) The skin is then washed thoroughly with soap and warm (not hot) water. This is done as soon as the tactical situation permits.

(*d*) If ointments are not available, the contaminated areas should be washed thoroughly with soap and warm (not hot) water.

Areas of the skin contaminated with liquid blister gases, whether already protected by the ointment or unprotected, must be decontaminated as soon as possible. If redness on the skin has appeared, cleanse the area only with soap and water. Protective ointment S–330 or S–461 is irritating to the reddened skin and shall not be used except when the liquid blister gas is still present and soap and water are not available for thorough washing. The importance of prompt action cannot be overemphasized. For example, proper skin decontamination for mustard during the first minute is always successful. After 3 minutes on a hot sweaty skin or 5 minutes on a cool dry skin, no method of decontamination will prevent blisters. However, self-aid procedures must be carried out as soon as possible to lessen the effects of the blister gas.

Order of procedure—Liquid blister gases.—Battle conditions permitting, each man upon contamination with any liquid blister gas *will instantly carry out all the self-aid procedures exactly in the following order:*

(*a*) Liquid blister gases evaporate. Therefore, breathe as little as possible until the eyes and face are decontaminated and the gas mask is in place.

(*b*) When the eyeshields have not been worn, decontaminate the eyes at once as described above. This must be done immediately after exposure; a delay of 2 minutes may result in blindness. If the eyeshields have been worn, discard them at once and carry on with decontaminating the hands and face unless some liquid agent has entered the eyes.

(*c*) The next step after the eyes have been decontaminated is to decontaminate the hands as outlined above under procedure for skin decontamination.

(*d*) Next, decontaminate the face.

(*e*) Then don the gas mask. It is very important to have the face thoroughly decontaminated before putting on the mask, since drops of liquid blister gas under the mask are dangerous because of the vapor from them which will be inhaled. The mask should be on the face within 5 minutes at the latest after exposure. With the mask in place, the eyes, face, nose, mouth, throat, and lungs are protected from further exposure to the gas.

(*f*) It is now necessary to decontaminate all other exposed skin of the body by the method already given. This should be done whether or not actual drops of the blister gas can be seen.

(*g*) Next, the clothing should be taken care of because drops of liquid blister gas on untreated clothing will penetrate to the skin beneath and produce damage. Impregnated clothing will offer protection to fine spray and small droplets. If battle conditions permit, it is best to remove all of the clothes, whether protective or nonprotective. If battle conditions prevent taking off the clothes, then tear out or cut out those parts that contain large splashes of liquid agent and carry out skin decontamination. After decontamination, it is best to wash the entire body with soap and warm (not hot) water. The clothing removed must be handled carefully since the blister gas contained in it continues to give off fumes which contaminate surrounding objects. This will be very dangerous in closed spaces where high concentrations of the fumes may be built up. Gas tight containers should be used to store contaminated clothing until it can be decontaminated.

As you know, the ointments will neutralize liquid blister gases, but the occasion may arise when ointments are not available. In such cases, wash the skin thoroughly with soap and water.

If all these steps are carried out exactly as outlined, within 5 minutes at the most, there is little to fear from liquid blister gases. You are able to carry on with your job. Should there be a delay in treating yourself, and if the skin is already red, protective ointments must not be used. Then, the only self-aid is to bathe the skin with soap and water gently and apply calamine lotion if available. If further irritation should develop, get help from a corpsman.

Order of procedure—Blister gas vapors.—The damage produced by blister gas vapors depends on the amount of vapor in the air, heat, humidity, and the length of time one is exposed. Upon detection of the vapor, instantly don the gas mask to protect the eyes, face, and lungs. The itching of the skin may be relieved by gentle bathing with soap and water, and by applying calamine lotion where available. The clothing should be removed as soon as battle conditions permit. It must be decontaminated or discarded so that poisonous fumes will not reach other men. If the eyes and skin become worse, report to a corpsman.

Self-aid for other gases

There are a number of other gases which you may not be able to identify because of the tactical situation, as they may be used alone or in mixtures, or may be covered up with screening smokes. It is important to remember *to hold your breath, and mask instantly upon detection of any war gas except liquid blister gas.* In the case of liquid blister gas contamination of the eyes or face, the procedure outlined above must be carried out prior to donning the mask. Your gas mask will give you adequate protection against the choking gases, blood and nerve poisons, vomiting gases, tear gases, and screening smokes.

Self-aid for choking gases

Now let us consider the choking gases. The most important of these gases are *phosgene* (CG), *diphosgene* (DP), and *chlorpicrin* (PS). They are so irritating to the nose, throat, windpipe, and lungs that they produce coughing, choking, and a feeling of tightness in the chest. They also cause a flow of tears from the eyes. In addition, chlorpicrin burns the eyes and skin. The important point to remember in the case of all choking gases is that the gas mask protects. Instantly upon detection, hold the breath, put on the mask, and exhale as completely as possible. The mask protects you from further exposure, and represents the principal defense. Other than this, there is very little that may be done. One must carry on unless breathing becomes difficult, which may occur 2 to 24 hours after exposure, or may not occur at all.

Self-aid for blood and nerve poisons

We come now to the gases known as blood and nerve poisons: *hydrocyanic acid* (AC), *cyanogen chloride* (CK), and *arsine* (SA). The important self-aid to remember in this case is *that the mask must be put on as soon as the gas is detected.* However, even with the mask donned, it is wise for the individual to get out of the gassed area as soon as possible. Be sure that any casualty from AC or CK is masked, and if he is unconscious, break two pearls of amyl nitrite and place under the mask. If breathing has stopped, give artificial respiration in addition, and obtain help from a corpsman.

Self-aid for vomiting and tear gases

The vomiting gases and tear gases may affect one even though a very small amount is in the air; but they normally do not produce serious injury. The use of these gases is mainly to harass by forcing wearing of the mask for long periods, thereby reducing fighting efficiency.

The vomiting gases (*diphenylchlorarsine* (DA), *Adamsite* (DM), and *diphenylcyanarsine* (DC)) are irritating and painful to the inside of the nose, and produce sneezing. They burn and pain the throat and windpipe, also produce a feeling of grittiness in the eyes, an aching of the teeth and gums, a sense of tightness in the chest, watering of the eyes, running of the nose, and vomiting. These results may not come on for several minutes after the presence of the gas is suspected. Even if the gas mask is put on right away, the pain in the nose and other bad effects may increase for a few minutes before they begin to disappear. Unless men are trained to expect this, they may believe that the gas mask leaks, remove it, and be further exposed to the vomiting gas or to a more deadly agent.

Self-aid consists of putting on the mask and keeping it on in spite of unpleasant sensations. During bouts of vomiting, the mask may be lifted temporarily from the face so as to keep it free of fluid. Sniffing fumes of chloroform gives some relief. A doctor's help is seldom necessary for exposure to vomiting gases. Their effects disappear quickly, usually within an hour or two.

Tear gases, *chloracetophenone* (CN) and its two solution forms (CNS and CNB) and *brombenzylcyanide* (BBC), produce strong stinging of the eyes, causing a marked flow of tears. In hot climates they also irritate the nose, throat, and skin. The self-aid for these effects is mainly facing upwind, allowing the tears to wash the gas out of the eyes, and putting on the gas mask. The eyes should not be rubbed because there is great danger of further contaminating them. The stinging of the eyes and skin may be relieved by washing with water. The effects of the tear gases wear off quite quickly.

Self-aid for screening smokes

Screening smokes (FS, FM, HC, and WP) in normal screening concentrations produce no injurious effects. The gas mask is required only in high concentrations such as may occur near the point of smoke production or in confined spaces. However, IF SMOKE IS IRRITATING, DON THE MASK. If breathing becomes difficult, remain quiet and comparatively warm until given medical attention. Beware of enemy smoke. It may contain deadly agents.

When white phosphorus is used as a screening smoke, particles of the phosphorus burn when they touch the body. The burning areas should be placed under water, or covered by cloth wetted with water, urine, saliva, or any other nonirritant and noninflammable solution. Copper sulfate solution, where available, is preferred above anything else, since it coats the particles of WP, and makes them painless. After the burning has ceased, remove the copper sulfate wet dressing. The particles must be removed. Grease, oil, or salves must not be employed because they dissolve the phosphorus and poison the body.

Liquid FS and FM produce acid burns, and the eyes and skin should be washed immediately following contamination.

Summary

In summary, we are now prepared to answer the questions originally stated. There is little to fear about gas warfare, providing we use our protective equipment properly, and providing we give ourselves prompt self-aid when contaminated.

Remember always that "an ounce of prevention is worth a pound of cure." Therefore, take care of your equipment, keep it handy and know how to use it so that it will protect you when needed.

Remember that the gas mask is the most important part of your antigas equipment. Learn how to don it quickly. Remember that for any liquid blister gas in the eye, use ointment BAL, massage the eye and wash out with water. For liquid blister gas on the skin, use protective ointment S–461 or S–330, follow with ointment BAL and soap and water.

REMEMBER THAT ON CONTAMINATION BY ANY GAS, SELF-AID OR WHAT YOU DO FOR YOURSELF, IS MOST IMPORTANT. The situation may be such that it will be impossible for you to help yourself. In this case, your nearest shipmate can assist you. SELF-AID IS THE RESPONSIBILITY OF ALL HANDS. SPEED IS ESSENTIAL. EACH SECOND'S DELAY INCREASES THE DAMAGE.

III

MATÉRIEL AND TACTICS

Possibilities of chemical attack

You are already familiar with the fact that the ultimate objective of naval combat is to sink the enemy's ships. Naturally, chemical weapons are unable to accomplish this objective by themselves. However, it is believed that chemicals can be used to increase the effect of high explosive munitions. The extensive use of the airplane in the present war has established the belief that if chemical warfare is initiated, chemicals can be expected in many air attacks against naval targets.

Vessels at anchor at an advanced base and vessels engaged in amphibious assault operations are particularly vulnerable to chemical attack. Landing craft and vessels engaged in close support bombardment may be subjected to most of the forms of chemical attack encountered ashore.

Advanced bases which may be attacked from air or sea should anticipate that chemical agents may be used in such attacks either alone or in combination with high explosives.

The use of chemicals against a fighting ship will reduce the accuracy and firepower of the ship by harassing or injuring the gun crews and exposed personnel. This is especially true of antiaircraft batteries. Chemicals can also be used to harass damage control parties and in this way slow up repair work on damage caused by high explosive shells. However, there are several features of both naval and chemical attack which limit and make chemical warfare difficult at sea.

For a chemical attack to be successful, hits must be scored on the target area as in a high explosive attack. The shell or bomb must hit the target, detonate, and spread the chemical agent over the personnel or equipment you wish to neutralize. Naturally such accuracy is made more difficult by the size and motion of a naval target. With near misses, much of the agent is lost in the water.

In addition to these usual characteristics of naval conflict, there are other difficulties which are inherent in chemical warfare itself. For example, many chemical agents react with the metal of the munition and cause leaks, in which case the munition and filling must be de-

stroyed. Then, the characteristics of some of the agents themselves render them useless for dispersion by armor piercing shells. Many of them are unstable to detonation—that is, the heat created by the detonation of the explosive charge causes the chemical to break down into harmless substances. Other agents are easily neutralized by water. Most of the easily vaporized agents like the blood and nerve poisons and choking gases would be ineffective at sea under normal conditions of use because of the relatively high wind velocities which are usually found there.

The blister gases probably will be used against naval targets more extensively than any other type of agent. Those containing arsenic, like Lewisite, which produce immediate irritation and intense pain, especially in the eye, may be used during an engagement, alone or mixed with other blister gases. The casualty effects of the blister gases are serious unless prompt self-aid measures are taken. In addition, blister gases reduce the efficiency of exposed personnel by forcing them to wear complete protective equipment. Areas contaminated with them must be cleaned up, since these gases are very persistent. Decontamination requires considerable time, effort and materials.

Vomiting gases, it is thought, may be particularly useful against amphibious forces. They would be used just prior to more deadly gases so that men who breathed the vomiting gas before donning their masks would become victims of the other agents if they removed their masks to vomit.

Chemical munitions

Chemical agents can be dispersed by airplane spray tanks, bombs, rockets, shells, grenades, smoke pots and candles, land mines and bulk containers.

Aircraft spray tanks

There are two main types of *spray tanks*—nonpressure and pressure. The nonpressure tank is of simple, light, inexpensive construction and produces a spray of fine droplets. The nonpressure tanks rely on the speed of the plane and the flow of air through the tank to disperse the agent. The air enters a small inlet tube on top of the tank, flows into the tank and pushes the agent out the discharge line in the rear. Both the inlet and discharge lines are opened from the cockpit. However, there is no means of stopping the discharge once it is started. The disadvantage of this feature to the Navy is evident—in order to hit a ship it is necessary to spray only a small area. If the nonpressure type tank is used, only one run may be made on the target and a large part of the agent is wasted on the open sea. Our pressure type spray tank uses carbon dioxide pressure, supplied by a cylinder

in the plane, to spray the agent. In this way, the pilot may start and stop the spray at will from the cockpit and make several runs on the target before the tank is emptied. Another advantage of the pressure tank over the nonpressure tank is that the agent is dispersed in larger drops. These large-size drops are less affected by the wind and also have a greater casualty effect on contact with the skin. The pressure tank is of heavy construction to stand the 70 pounds carbon dioxide pressure. The discharge line runs from the rear of the tank and may be raised or lowered depending on the carrying position of the tank. It may be carried under the wings, under the bottom of the fuselage, or in the bomb bay.

The blister gases and tear gases can be sprayed in the same manner as the smoke-producing agents. Tear gas spray is very fine and is greatly affected by wind action as it falls. Blister gas spray is made up of larger drops which are not as subject to wind action as fine spray, and also creates a greater degree of contamination. Since the freezing point of mustard is rather high, mustard tends to freeze in a spray tank if the plane flies at even moderate altitudes for a period of several hours. To prevent freezing, a mixture of mustard and Lewisite may be used. The mixture has a very low freezing point and largely overcomes the freezing difficulty. The tanks may also be wrapped with an insulating material to keep the mustard from freezing.

High altitude spray from 20,000 feet or above, which could be delivered without the knowledge of the enemy, would be ideal. But this type of spraying is difficult since it takes the spray a long time (20 minutes or more) to reach the target, and in naval warfare it is almost impossible to release a chemical agent so that it will fall on the spot where the target will be 20 minutes later. Experience will probably show that a better method is to include a number of spray-tank equipped planes in a preliminary air attack. The combination of chemicals and high explosives would serve several purposes: (1) The combination might surprise the enemy; (2) if a sufficient concentration of agent is laid down, the enemy may be forced to cease firing long enough to protect himself from gas, and such action would leave the ship open to uncontested bomb or torpedo attack; (3) the chemical agent might not be detected since the odors created by explosives very often mask the odor of the agent.

The second statement deserves a brief added comment. It is the policy of our Navy not to cease fighting to don protective equipment. Equipment will be donned as soon as battle conditions permit. However, if a high enough concentration of tear gas, for example, is laid down on exposed men, they will be physically unable to operate their guns accurately. This is the type of concentration which must be laid down to gain the advantage.

Chemical bombs

As has already been mentioned, the corrosive action of agents on metals requires that chemical bombs be made of relatively heavy gage metal. The present trend is to drop large numbers of small bombs filled with blister gas to give a wide dispersion of the agent. It is thought that bombs filled with blister gas will be the most effective against sea targets. However, against amphibious forces and ships at anchor, choking gases and blood and nerve poisons may be dispersed in large bombs. Large bombs could quickly build up a "crash" concentration before personnel could mask. Bombs are especially useful in creating a heavy contamination at a particular point, while spray produces a more or less uniform contamination over an entire area. It may be desirable to contaminate heavily a particular antiaircraft battery or superstructure already wrecked by high explosive.

Chemical shells

Chemical shells are the last main division of chemical warfare weapons. The Navy has a 5-inch white phosphorus smoke shell. This shell is a base ejection type which bursts in the air and creates a smoke cloud as the white phosphorus falls through the air. The air burst feature of the shell makes it useful over water as well as over shore installations. The screen is easily shifted or maintained by firing additional rounds.

This WP shell can also be used for its casualty effect. As a result of its use in the invasion of Sicily, it was discovered that serious casualties were produced very quickly, and in addition, there was a great degree of surprise in the attack.

Another chemical shell which may be used is an armor-piercing shell with a small amount of tear gas in it. Naturally, all the personnel in a compartment in which an AP (armor-piercing shell) bursts will be killed and the compartment will be damaged by the high explosive. The tear gas vapor released on detonation will condense on the bulkheads and then continue to give off a harassing concentration for some time. The presence of this gas will force any repair parties working in the compartment to wear masks. Masks reduce efficiency, so it will take the repair party longer to restore the watertight integrity of the ship. In this way the effect of high explosives can be increased.

Miscellaneous munitions

Chemical grenades may be thrown by hand or projected from a rifle or special projector. Their principal use is against personnel in confined spaces, but they may also be used to set up small local smoke screens or as incendiaries. The common fillings for chemical grenades are tear gases, vomiting gases, smokes, and incendiaries. In addition

an agent such as hydrocyanic acid might be used in a frangible container.

Smoke pots and candles are small generators of vomiting gases, tear gases, or screening smokes. The smoke is produced by the combustion or heating of the agent. Ordinarily smoke pots and candles are placed at intervals on the ground or water to generate a cloud of toxic or screening smoke. In some cases they may be fired from special projectors.

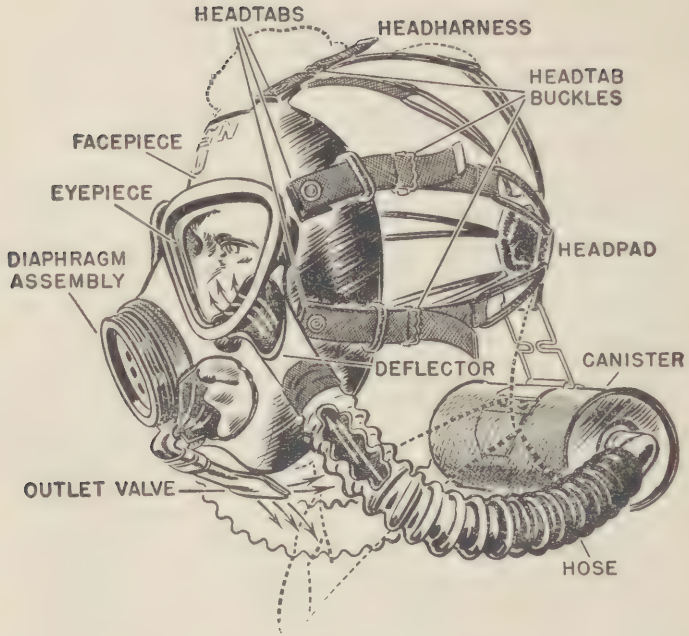
Chemical land mines are containers filled with blister gas and equipped with an exploding device which scatters the agent over the surrounding ground. They are used primarily by a defending or retreating force to contaminate strategic points or areas such as road blocks or beachheads.

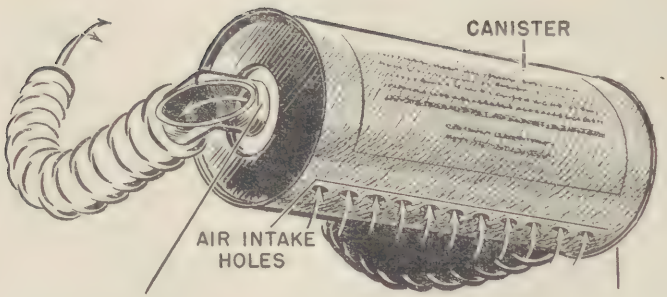
Bulk contaminators are truck-mounted containers of chemical agents fitted with spraying or sprinkling devices so that they may be driven over roads, runways, etc., and the agents dispersed over the ground. Their probable use would be with blister gases by a retreating force to deny roads, beaches, or other strategic areas to the advancing force.

Use of chemical warfare agents

Now to consider how chemicals might be used. Probably the most extensive use would be against shore installations. In deciding what type of agent to use, one important question must be decided. "Do we want to take the area or merely deny it to the enemy?" If we want to drive the enemy out and not take possession ourselves, we would use a persistent agent like mustard; use any means possible to lay it down as quickly and as heavily as possible. This would either force the enemy to leave the area or take a lot of casualties—in any event the enemy would be denied the use of the area.

On the other hand, if we want to move into the area ourselves soon after the chemical attack, we must use some quickly vaporizing agent or suffer casualties ourselves from a persistent agent. Under such conditions the gas should be laid down at least a half hour before the intended attack so that all of the agent will have been dispersed before our own men arrive. In this way we would get all the good effects of the gas by making casualties of some of the enemy troops and at the same time have no worries about any danger to our own men. The many landing operations necessary in this war offer many opportunities for the effective use of chemicals.





INLET VALVES LOCATED AT EACH END OF CANISTER

NOMENCLATURE OF NAVY MK 4 GAS MASK

IV

PROTECTION

INDIVIDUAL PROTECTION

The gas mask

The basic item of equipment for individual protection against chemical warfare agents is the gas mask, as it protects the face, eyes, and respiratory tract. It is necessary that you know the value of the gas mask, when and how to use it, and how to care for it. The gas mask drill and the care of the mask are discussed in subsequent chapters.

The operation of the mask is briefly as follows: When the wearer inhales, air is drawn into the mask through the intake holes in the canister. The air passes through the canister where it is purified and then through the hoses to the facepiece. After being inhaled and exhaled, the air is expelled from the facepiece through the outlet valve.

At present there are four Navy masks: The ND Mark 3, ND Mark 4, NDO Mark 1 and the NC Mark 1. The letters "ND" refer to "Navy Diaphragm," the letters "NDO" to "Navy Diaphragm Optical," and the letters "NC" to "Navy Civilian." The ND Mark 3 and 4 and NDO Mark 1 masks are similar except for the eyepieces. The NDO masks are provided for personnel who must use optical instruments. The ND Mark 3 and 4 and the NDO Mark 1 masks are the main general service Navy masks and are issued to all shipboard personnel and some shore-based personnel. Other shore-based personnel are issued the Army Lightweight Service Mask, the other gas mask you will find discussed here.

Nomenclature of Navy masks

Before one can talk intelligently about any object he must first become familiar with its various parts. Let us, then, take up the nomenclature of the Navy gas mask.

First is the *Canister*. This is the part of the mask that purifies air. Remember that it does *not* supply oxygen; it merely purifies the contaminated air of chemical warfare gases. The air enters the canister through the air intake holes.

Next are the *Inlet Valves*. There is an inlet valve at each end of the canister at the junction of the hose and the canister. The inlet

valves are check valves which allow air to pass from the canister to the hoses, but prevent it from flowing back into the canister when the wearer of the mask exhales.

The *Hoses* are the conducting tubes through which the purified air passes from the canister to the facepiece.

The *Facepiece* is the part of the mask that covers and protects the face.

The *Lenses* or *Eyepieces* are provided so that the wearer can see while using the mask.

The *Deflectors* are the fan-shaped tubes below the eyepieces that direct the air from the hoses up over the lenses and into the facepiece. This helps prevent fogging.

The *Diaphragm Assembly* contains four sheets of cellophane paper for sound transmission, so that individuals wearing the mask may easily communicate with each other.

The *Outlet Valve* is attached at the bottom of the diaphragm assembly and the exhaled air leaves the mask through it. The inlet and outlet valves are designed to permit air flow through the mask in only one direction: from the canister to the face, and from the face to the outside. In this way no contaminated air can get to the face without first entering the canister and being purified.

The *Head Tabs* are fastened to the sides of the facepieces. There are six of them and they fasten the head harness to the facepiece. At the end of each tab is a buckle through which the head harness straps are threaded.

The *Head Harness* is composed of the webbing straps, elastic loops, headpad, and canister bail. The headpad is seated at the center back of the head.

The *Carrier* is the water-proofed canvas bag which holds the mask when it is not in use.

Army Lightweight Service Mask

The canister of the Army Lightweight Service Mask is always kept strapped into the carrier which must be worn whenever the mask is on the face. The canister is connected to the facepiece by a single hose, which is longer than the hoses on the Navy mask. There is no diaphragm assembly. Other individual parts of the mask are also different in appearance from those of the Navy mask, but you should be able to identify them and tell their function from the nomenclature of the Navy mask given above.

Eyeshields are standard equipment aboard ship and ashore in theaters of operations. They protect the eyes against liquid war gases, but not against vapors. They do not protect the rest of the face or the lungs, but are worn when a spray attack is expected. They do not impair work as does the mask, and they will protect the eyes in

an actual spray attack until the mask can be donned. The eyeshield is discarded after contamination. They are kept in the gas mask carrier.

Individual protective covers are made of impermeable material with a cellophane-like top, and are tent-like in appearance. They are issued to advanced base personnel for protection against airplane spray of liquid chemical agents. With practice they can be put on in a few seconds while the attacking plane is coming in and before the spray hits. They are discarded if contaminated. These covers are also kept in the gas-mask carrier along with the mask.

Protective Ointments S–461, S–330 and **Ointment BAL.** You have already learned about the use of these ointments under self-aid. Tubes of them are issued to all hands. The importance of being able to distinguish them by feel alone has been stressed. Don't forget where in your gas mask carrier you keep them.

Antidim, while not an item of protection, comes with the gas mask in the carrier. It is used to prevent the eyepieces of the mask from fogging. More detailed instructions on how to apply it will be found in a later chapter.

All these items just mentioned make up the authorized equipment to be kept in your gas mask carrier. In addition to these items, which are of general issue, there is additional individual protective equipment which is given to exposed personnel and members of the decontamination parties aboard ship and all personnel at advanced bases.

Protective clothing is the most important item of this equipment. You have learned in *Agents* how blister gases penetrate ordinary clothes and burn the skin. The Navy has provided chemically treated impregnated protective clothing which protects the body from vapors and small droplets of blister gas. Each outfit of protective clothing consists of a two-piece suit (overalls and jumper with hood), one pair of blue woolen gloves, and two pairs of cotton-wool socks. The suits are dyed for camouflage. When properly donned with gas mask and proper footgear, an individual is afforded good protection against normal field concentrations of blister gas. However, it is important that you follow the prescribed procedure for putting on and taking off the clothing in order to obtain full protection and to avoid contaminating yourself. Aboard ship, rubber overshoes are worn with protective clothing.

Shoe impregnite is issued to advanced base personnel to render shoes resistant to blister gas. It is an oily-waxy substance, coming in tubes or cans, which fills the pores of the leather, thereby sealing them against the blister gas. However, the gas is not destroyed, so the outside of contaminated shoes is still highly dangerous until decontaminated.

COLLECTIVE PROTECTION

In addition to the individual protective equipment supplied to all hands, there are various means of collective protection available both at sea and ashore. The gas alarm will be given afloat and ashore in accordance with the gas defense bill.

Collective protection at sea.—Aboard ship, closure of openings in the outside envelope and the shutting down of the ventilation system prevent the spread of war gases into the interior of the ship. In addition, the gas defense bill provides for gas cleansing stations where contaminated individuals will carry out the prescribed routine for removal of contaminated clothing and additional personal decontamination.

Collective protection ashore.—At advanced bases and ashore where gas attacks are expected, gasproof shelters will be provided. These may be of two types—ventilated or nonventilated. The ventilated shelters are equipped with power-driven collective protectors. These consist of a blower which draws the outside air through a large canister which removes war gases and then forces it into the shelter. They provide a constant flow of fresh air to the occupants. Nonventilated shelters are gastight buildings without any provision for supplying fresh air. They will accommodate only a limited number of men for a limited period of time, as the temperature and humidity rise rapidly until the conditions ultimately become unbearable.

All types of gasproof shelters have the same basic plan, consisting of an undressing area, air lock, and shelter proper. The undressing area is the place provided where personnel discard their contaminated clothing so as not to carry dangerous vapors into the shelter proper. The air lock, a small gastight vestibule, prevents contaminated air from passing from the undressing area into the actual shelter. The shelter, which may consist of one or more rooms, should be equipped with toilet facilities, drinking water, and electric lights.

V

CARE AND DISINFECTION OF THE GAS MASK

The gas mask is the chief piece of protective equipment, for it removes all of the chemical agents from any inhaled air, thereby protecting the eyes, face, and lungs from the effects of these agents. When masks are issued, the individual becomes responsible for the care and operation of his own mask. He should inspect it frequently and keep it in good working order at all times so he may use it at any time without previous warning. In order that this may be done, a certain set of rules has been established:

First: **Keep the mask dry.**—This refers chiefly to the canister. If the charcoal contents get wet, they tend to cake, and contaminated air may pass through the canister and on into the facepiece without being purified. Individuals wearing the mask will then be breathing contaminated air. *So in the case of a wet canister, have it replaced.* If this is impossible, try to dry it carefully by leaving it in a warm room for 2 to 3 days. This should be done *only in an emergency.* Moisture also causes rotting of the rubber, corrosion of metal parts and mildewing of the head harness straps and the carrier.

Some masks are furnished with adhesive tape over the air inlet holes. After this tape is removed, it should not be replaced.

Second: **Keep only authorized equipment in carrier.**—Carriers were designed for a specific purpose; namely, to carry certain individual protective equipment. The authorized equipment includes the mask, antidim, Protective Ointment S–461 or S–330, Ointment BAL, eyeshields, and the individual protective cover if issued. The addition of anything else will prove harmful, both to the carrier and its contents.

Antidim is the name that is given to the material that is used to keep the eyepieces from fogging. It comes in three forms, the first of which is the stick or crayon form. This is applied by drawing the crayon across the inside of the lens and then taking the cloth and getting an even distribution of the material on the lens. This has one disadvantage in that the crayon tends to pick up dirt and when drawn across the lens, the dirt scratches it, thereby hindering proper vision. The second form is a paste. It comes in small tubes and is applied by squeezing a little on the finger and then rubbing it on the lens. The third and last form is a piece of chemically treated

cloth. To use it, one moistens his fingers and wipes the lens with the wet fingers. Then the cloth is used to dry the lens. It should also be mentioned here that antidim may be applied to the outside as well as the inside of the lens.

Third: **Handle mask gently.**—Masks will stand a certain amount of abuse, but you must handle them with some common sense. Do not use your mask for a pillow or a football; do not kick it around or leave it for someone to step on; and do not place it near a radiator or steam pipe. Remember that a single hole in the facepiece, hose, or canister may ruin the entire protection of your mask. If you treat your mask properly, it will cause no trouble.

Fourth: **Do not overstretch the head harness.**—If this is done, the facepiece will not form a tight seal around the face, and contaminated air will be able to get into the mask. Take a little care in putting the mask on not to stretch the head harness unduly, especially when adjusting it to the face. Keep the head harness as loose as possible without losing the fit.

Fifth: **Replace mask properly in carrier.**—When you are through with your mask, be sure that it is returned to the carrier in the proper manner. If this is not done, the facepiece may lose its shape or the hose may be bent in such a way as to deteriorate rather rapidly. Another good reason for replacing the mask carefully is that if you have to put the mask on in a hurry, and it is in the carrier in an improper manner, extra time will be needed before you can obtain protection. Time is very essential in dealing with gas, so it will be of advantage to you to cut it to a minimum.

Sixth: **Stow mask properly.**—When masks are put away for any length of time, be sure that they are kept away from *all heat*, light, and water. Heat and light will ruin the rubber and moisture will ruin the canister. Be sure that they are never stacked more than five or six high, and that no heavy material is piled on top of them. A cardboard faceform is provided with new masks which will help keep the facepiece in shape and from sticking together. If no faceform is available, it is an excellent practice to stuff crushed newspaper or some similar material inside of the facepiece if the mask is to be stowed for any length of time.

Seventh: **Inspect mask frequently.**—Masks should be inspected both when in use and when in stowage, for it is the only way to be sure that the mask is in proper working order. An easy and efficient way to do this is by tracing the flow of air through the mask.

Air enters the mask at the perforations in the canister.

Examine the canister for any punctures, dents, or rust spots. Shake it to see if its contents rattle. If the contents rattle, have the canister replaced.

Check the connection of the hoses and the canister by pulling on them.

Inspect the hoses for any holes or tears by stretching them in short sections and going over them very carefully.

Examine the connection of the hoses and the facepiece.

Inspect the facepiece the same way as the hose—by stretching it and looking for any holes or tears. Be sure to cover the entire facepiece and not merely a few spots here and there. Check particularly around the lenses, diaphragm assembly and head tabs, places where there are attachments to the facepiece.

Check the lenses to see if they are shrunken, broken, loose, distorted, colored, or scratched in such a way as to hinder proper vision. Your mask cuts down your vision somewhat, so you do not want to increase the hindrance to vision by having defective eyepieces.

Be sure that the cellophane paper in the diaphragm assembly of Navy masks is not torn. If it is damaged, air will pass through it and into the facepiece and defeat the purpose of the mask.

See that the outlet valve is fastened properly to the facepiece, is clean and is not torn. Outlet valves will leak when clogged with dust, sand, or other foreign matter. Occasionally, after disinfection, and also during cold weather, the edges of the valve will stick or freeze and the valve will then require cleaning. Outlet valves can be cleaned by wiping with a dry cloth, or if necessary, with a cloth moistened with warm water. The outlet valve ports of the ND Mark 3 and 4, the NDO Mark 1, and the NC Mark 1 masks can be cleaned with a cloth wrapped around a small stick. The disk type outlet valve is found in the Army Lightweight Service Mask. In these types, both the rubber disk and the valve seat must be cleaned. The top of the outlet valve guard may be removed by unscrewing. Talcum powder sprinkled on inner surfaces of the outlet valve will usually prevent further sticking. In extremely cold weather it may be necessary to improvise a cloth bag to cover outlet valves to keep them from freezing.

Inspect the head tabs to see that they are firmly fastened to the facepiece.

Check the head harness and be sure that it is not torn or has not lost its elasticity and is fastened properly to the headpad.

Don the mask and check the resistance of the canister to inhalation. If at any time the resistance of the canister to inhalation is found to be excessive, it should be replaced, as the high resistance is probably due to caked or damaged chemicals.

You can see that by inspecting the mask while tracing the flow of air through it, there is very little danger of overlooking any of the vital parts of the mask.

Major repair should be attempted only by experienced personnel. *In an emergency* minor repairs may be made by using any type of adhesive or friction tape or cold patch.

Carriers are waterproofed, so be sure that there are no holes or tears. See that the hook-and-eye clasp and the lift-the-dot fasteners are in good working order. If the carrier tends to mold, clean it by using a 2-percent acetic acid solution, or ordinary vinegar.

Eighth: **Disinfect mask thoroughly.**—This is done chiefly for sanitary reasons. Masks should be thoroughly disinfected whenever they are stowed, exchanged, or used by more than one individual for training purposes, or when the wearer has been suffering from a cold, sore throat, or other infectious disease. Dirt should be removed with soap and water before starting disinfection.

The Navy has available on its supply table approved disinfectants for this purpose. They are issued under several trade names and in several concentrations under Bureau of Ships, Stock No. 51–D–394 and by the Bureau of Medicine and Surgery, Stock No. 1–851, or under the trade name "Zephiran," Stock No. S1–4790. These disinfectants do not damage the mask and allow wearing of the mask within 30 minutes after disinfection is completed. The solution must be diluted in accordance with instructions appearing on the container label. It should be used as follows:

1. In disinfecting the mask, keep the facepiece lower than the hose and canister to prevent the disinfectant from running into them. Hold the facepiece in the hand, saturate a small piece of clean rag with the disinfectant, and sponge the entire surface of the facepiece, including the outer and inner sides of the deflectors. In this operation do not turn the facepiece inside out. Then apply the disinfectant to the outside of the outlet valve.

2. Squeeze a few drops of the disinfectant from the rag into the exit passage of the outlet valve. Open the outlet valve with the fingers to let the disinfectant run out. Do not shake off the excess.

3. Also disinfect the inner surface of the diaphragm assembly. Excessive wetting of the internal parts must be avoided by keeping them above the general level of the area being treated.

4. Allow all disinfected parts to remain moist for about 15 minutes and then wipe the facepiece with a clean dry rag. The mask should then dry thoroughly in the air (usually 30 minutes) before it is returned to the carrier.

If one of the standard disinfectants is not available, ordinary soap and water may be used. If soap and water are used, the mask must be allowed to dry thoroughly before stowage.

There are objections to the use of formaldehyde, cresole, lysol, Dakin's Solution, hydrogen peroxide, copper sulfate, alcohol and

other disinfectants. They either damage the mask, have a low antiseptic value, persist for a long time necessitating many hours for airing and ventilation, or they irritate the skin and breathing passages.

Ninth: **Test the mask periodically** in a gas chamber to make sure it is in perfect working order.

Summary.—In closing, let us briefly review the rules for the care of the gas mask:

1. *Keep mask dry.*
2. *Keep only authorized equipment in carrier.*
3. *Handle mask gently.*
4. *Do not overstretch the head harness.*
5. *Replace mask properly in carrier.*
6. *Stow mask properly.*
7. *Inspect mask frequently.*
8. *Disinfect mask thoroughly.*
9. *Test the mask periodically.*

VI

GAS MASK DRILLS

A gas mask drill is an established routine designed to instruct an individual to don the mask properly and gain protection from chemical agents as quickly and easily as possible. It is important to learn the drill carefully, in order to avoid unnecessary motions. This requires repeated practice. Once a drill is learned, it is not forgotten, and a person will be able to protect himself from war chemicals by force of habit almost without thinking, as soon as the alarm is given.

For instructional purposes, the drill is performed "by the numbers," so that each step may be learned carefully in the correct order. This should be followed by practice without the numbers to acquire proficiency in the speedy donning of the mask. When proficiency has been attained in masking without the numbers, practice should be continued to insure that personnel can mask efficiently regardless of the body position or activity, e. g., prone, kneeling, or double timing. Training in masking with the eyes closed, to simulate conditions of darkness, is also essential. All drills are given "at ease." In an actual gas attack, the mask is put on as quickly as possible. The breath must be held from the time of the first detection of gas, the sounding of the alarm or the command **"GAS,"** until the mask is donned, cleared, and checked. In drills "by the numbers," however, men should not be expected to hold their breath throughout the donning, clearing, and checking of the mask.

The Navy drill for Mark 3, Mark 4, and NDO Mark 1 gas masks

In donning the Navy mask "by the numbers," it requires *four* counts to place the mask on the face and in operation.

For drill by the numbers, the command is: "By the Numbers, **GAS."** At the command **GAS,** dispose of arms and loose equipment. Remove and dispose of head covering. (Pass the head or chin strap of head covering over right arm. Soft caps are disposed of by placing under the belt, between the knees, or in the pocket. Be careful not to let the headpiece touch the ground, where it might become contaminated.) With the left hand, slide the carrier forward in front of left hip. Hold it at the bottom with the left hand, and open flaps with

the right hand. Remove the mask with the right hand by grasping the diaphragm assembly with the outlet valve between the first and middle fingers, and lifting straight up. Hold mask in front of the face with the front away from the body. With the left hand, thumb underneath, grasp the canister between the canister clip and the left hose. Still retaining grip on the canister with the left hand, allow the facepiece to fall forward. With the thumb and index finger of the right hand, encircle hose and lower head harness strap together on the right side as close to the canister as possible; do the same on left side with left hand. (By keeping the grip as close to the canister as possible, more room is given for the face to enter the mask.) Extend the lower three fingers of each hand to thrust the headpad upward, maintaining grasp on hoses and lower head harness straps with thumbs and index fingers. Raise mask face high; thrust chin forward.

TWO. Seat facepiece firmly on chin and move canister and head harness into place with an upward, backward sweep of the hands. Seat head harness with headpad at center back of head; fit mask to face by smoothing out edges of the facepiece from bottom to top. Be sure the head harness straps are not twisted and that the ends of the straps are not caught anywhere on the mask.

THREE. Close outlet valve with thumb and fingers or press the valve against the chin and exhale vigorously. (This action clears the facepiece of any contaminated air that might be present, and is called "clearing the mask.") Next, using both hands, grasp the two hose tubes as close to the canister as possible and pinch the walls of the tubes together in order to shut off all passage of air from the canister. Inhale. The facepiece should collapse against the face and the wearer be unable to breathe. (This tests the fit of the mask against the face and is called "checking the mask.")

FOUR. Replace headgear. Fold inner carrier flaps in and fasten the outside flap. Return the carrier to original position at rear of left hip, thus completing the first part of the gas mask drill.

The second part of the drill is removing and replacing the mask. For instructional purposes this is also done "by the numbers." The command is, "By the Numbers, Remove and Replace **MASK.**" First, **TEST FOR GAS:** Take a moderately full breath, exhale part of the air breathed, and stop breathing. Stoop to bring the face as close to the deck as possible without touching any part of the person or equipment, other than the feet, to the deck. Grasp one of the lower head harness tabs on the side of the mask and pull facepiece slightly away from the face to break the seal against the face to allow air to enter. Sniff gently but do not inhale. Resume the erect position. Clear the mask as previously described. Resume normal breathing. (*Personnel must always test for gas before removing the mask.*)

If no gas is detected, continue to remove mask. Remove the headgear and hold it in the left hand, and with the right hand grasp the diaphragm assembly. With a downward, outward, upward, and backward motion, remove the facepiece. Place mask on crook of left arm with the canister on the outside of the arm and the facepiece on the inside with outlet valve up. Replace headgear using both hands. Regrasp mask with right hand by the diaphragm assembly with the outlet valve between the first and second fingers, and bring to a position in front of the body with the outlet valve to the front.

TWO. With the left hand, bring carrier to a position in front of the left hip. With the right hand, which is holding the mask, steady carrier against hip, and with left hand, open carrier flap, and spread carrier open. Start canister in carrier with outlet valve away from body.

THREE. Push canister to bottom rear of carrier with the left hand. Place facepiece in carrier with diaphragm assembly parallel to the deck. Shake carrier with both hands. The hoses should shake down easily at the sides and the facepiece settle with the diaphragm assembly parallel to the deck. (The mask is then most readily available for the next use.) Refasten both inner and outer flaps of the carrier, and return carrier to rear of left hip. The gas mask drill is now completed.

NAVY GAS MASK DRILL

DONNING THE MASK

FIGURE 1.—Headgear disposed of.

FIGURE 2.—Carrier brought around to front of body from left hip. Carrier opened.

FIGURE 3.—Mask removed from carrier with right hand by grasping diaphragm assembly with outlet valve between first and middle fingers.

FIGURE 4.—Overhand grasp on canister with left hand.

FIGURE 5.—Facepiece released from right hand.

FIGURE 6.—Hoses and lower head harness straps encircled by thumb and first finger of each hand. Headpad raised by remaining fingers extended.

FIGURE 7.—Mask ready to be seated on chin and drawn up onto face.

FIGURE 8.—Mask seated on face. Clearing facepiece.

FIGURE 9.—Checking the mask.

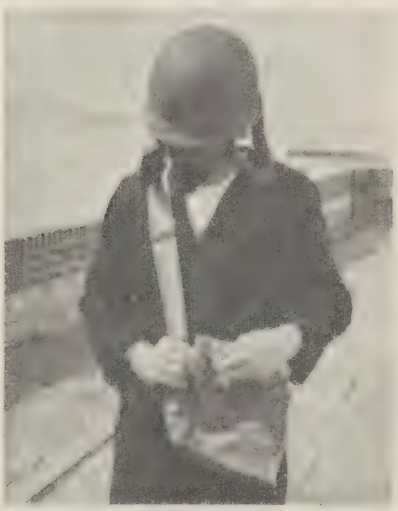


FIGURE 10.—Headgear returned to head. Carrier being closed prior to replacing to rear of left hip.

REMOVING THE MASK

FIGURE 11.—Testing for gas.

FIGURE 12.—Headgear removed with left hand. Mask removed from face by grasping diaphragm assembly with right hand.

FIGURE 13.—Mask placed over crook of left arm, canister outside, facepiece inside with outlet valve up.

FIGURE 14.—Headgear returned to head. Mask regrasped. Opening carrier with left hand, using right hand to steady carrier against hip.

FIGURE 15.—Starting mask in carrier, outlet valve away from body.

FIGURE 16.—Mask replaced in carrier. Carrier closed, returned to rear of left hip.

Army Lightweight Service Mask drill

The Army Lightweight Service Mask may be slung in several positions, the position being chosen to fit the occasion and equipment carried.

FIGURE 1.—Sling MASK: Hold shoulder strap of carrier in palm of left hand, flap of carrier away from body.

FIGURE 2.—Form large open loop with shoulder strap. Swing strap over head, passing left elbow through loop.

FIGURE 3.—Place strap at junction of neck and right shoulder. Position carrier at left side.

FIGURE 4.—TWO. Adjust body strap to pass around body and fasten to small D ring at lower left corner of carrier.

"By the Numbers, **SIDE CARRY, SLING MASK**"

FIGURE 5.—Sling MASK: Proceed as with "side carry" until carrier is positioned at left side (figs. 1, 2, and 3).

FIGURE 6.—TWO: Shorten shoulder strap by hooking harness snap into D ring on upper right corner of carrier.

FIGURE 7.—Adjust body strap to pass around body and fasten to small D ring on lower left corner of carrier.

FIGURE 8.—Mask slung at gas alert carry. Carrier straps should be adjusted so that carrier is well up on chest.

"By the Numbers, **GAS ALERT, SLING MASK**"

FIGURE 9.—Sling MASK: Proceed as with "side carry" until the carrier is positioned at left side (figs. 1, 2, and 3).

FIGURE 10.—TWO: Shorten shoulder strap by hooking harness snap into D ring on upper right corner of carrier. Slide carrier around under left arm to position on back.

FIGURE 11.—Pass body strap across back (over equipment), around the right side and fasten to sliding loop on shoulder strap.

FIGURE 12.—Mask slung at back carry. Carrier in diagonal position on back. [With full pack, carrier suspended high to left of pack. (See fig. 21.)]

"By the Numbers, **BACK CARRY, SLING MASK**"

Donning the mask

It takes *four* counts to don the mask. The command is: "By the Numbers, **GAS.**" At the command **GAS,** dispose of arms and loose equipment. If not already in *gas alert position*, carrier must be moved to front of body. Remove the headgear. Pass head or chin strap of headgear over the left forearm. (Soft caps and headgear without head or chin straps are secured by placing under the belt, between the knees or in some other convenient manner. Care must be taken not to let the headgear touch the deck where it might become contaminated.) Hold bottom of carrier with right hand and open flap with left hand. Grasp facepiece above the eyepieces with the right hand and remove from the carrier. Grasp the facepiece with both hands, sliding the thumbs up inside the facepiece at the edge and under the lower and middle head harness straps, and place the extended fingers on the outside of the facepiece above the eyepieces. Bring facepiece up in front of the face and thrust out the chin.

TWO. Seat chin pocket of the facepiece firmly on the chin, and holding the head stationary, move the head harness into place with an upward, backward sweep of the hands. Seat head harness with headpad at center back of the head. Fit mask to face by smoothing out edges of the facepiece from bottom to top. Be sure head harness straps are not twisted and that the ends of the straps are not caught anywhere on the mask.

THREE. "Clear the mask": Close outlet valve by placing the palm of the right hand firmly over the valve guard and exhale vigorously. This clears the facepiece of any contaminated air. "Check the mask": Using both hands, grasp the hose near the canister and pinch the walls of the tube together in order to shut off the passage of air from the canister. Inhale. The facepiece should collapse against the face and the wearer be unable to breathe. If it does not, the fit of the mask or the mask itself is defective.

FOUR. Replace headgear. Fasten flap of carrier. If carrier is to be carried at gas alert carry, the hose should come out of the right end of the carrier. If carrier is to be carried at back carry, the hose should come out of left end of carrier.

When mask has been carried at the back carry with pack, it will ordinarily be returned to the back carry. Otherwise it will be placed at the gas alert carry. To return it to back carry, the shoulder strap is extended by unfastening the harness snap, and the carrier is moved to the rear. Pass the left arm between the hose and body. The shoulder strap is then shortened by hooking the harness snap into the D ring on upper right corner of carrier. The carrier is brought up in position at the left of the pack so the hose comes over the left shoulder.

The body strap is then fastened around the pack to the sliding loop on the shoulder strap.

The mask being donned: *To remove and replace mask*, the command is "By the Numbers, remove and replace **MASK.**" At the command, **MASK,** first **TEST FOR GAS,** as described in the Navy Gas Mask drill. If no gas is detected, continue to remove the mask. Remove the headgear and hold it in the left hand. With the right hand, grasp the facepiece below the eyepieces. With a downward, outward, upward, and backward motion, remove the facepiece. Place it in the crook of the left arm. (If the carrier is on the back, allow facepiece to hang over the left shoulder.) Replace headgear using both hands.

TWO. Grasp facepiece with right hand. (If carrier is slung on back, bring to gas alert position.) With the left hand, fold headharness inside the facepiece. With right hand, which is holding the mask, steady the carrier, and with the left hand, open carrier. With the left hand, straighten out canister straps. Grasp canister with the left hand, thumb on top, fingers underneath, and lift canister out of carrier. Loop hose around canister lengthwise, and place canister inside facepiece, with canister inlet valve at chin of facepiece. Grip canister through the facepiece above the eyepieces with the right hand, and start the hose loop into the carrier.

THREE. Place mask in carrier and fasten flap. Return carrier to original carrying position. The Army Lightweight Service Mask drill is now completed.

ARMY LIGHTWEIGHT SERVICE MASK DRILL

DONNING THE MASK

FIGURE 13.—Headgear disposed of.

FIGURE 14.—Carrier opened. Mask being removed.

FIGURE 15.—Thumbs underneath head harness straps; fingers extended outside above eyepieces. Mask held in front of face.

FIGURE 16.—Mask seated on face. Clearing mask.

FIGURE 17.—Checking mask. (Mask should collapse against the face.)

FIGURE 18.—Headgear returned to head. Carrier being closed for gas alert carry position.

FIGURE 19.—With pack. Hose out of left end of carrier. Left arm passed between hose and body. Shoulder strap shortened by hooking harness snap on D ring.

FIGURE 20.—Carrier on back at left of pack. Body strap fastened around pack to sliding loop on shoulder strap.

FIGURE 21.—Final position of carrier at back carry with mask donned.

MASK WORN AT BACK
CARRY WITH PACK

REMOVING THE MASK

FIGURE 22.—Testing for gas.

FIGURE 23.—Headgear in left hand. Mask being removed by right hand.

FIGURE 24.—Headgear being replaced. Facepiece of mask in crook of left arm.

FIGURE 25.—Folding head harness straps into facepiece with left hand.

FIGURE 26.—Carrier, steadied at bottom with right hand, being opened by left hand.

FIGURE 27.—Canister grasped in left hand (hose folded around lengthwise) being inserted into facepiece, inlet valve next to chin.

FIGURE 28.—Canister grasped through mask above eyepieces with right hand. Mask being seated in carrier, hose loop first.

FIGURE 29.—Mask in carrier. Carrier flaps being fastened.

Adjustment of mask.—When you are issued a gas mask, usually you will find upon donning it and testing for fit that the mask leaks air around the facepiece, or else that it is fitted uncomfortably tight on your face. In either case, the head harness needs adjusting so that the mask will fit snugly but without undue pressure. To adjust the head harness for a correct fit of facepiece with either the Army or Navy mask, first loosen all six straps. You will find that if you hold the head tab buckles outward at right angles to the head tab strap itself, the head harness straps may be eased through the buckles without much trouble by gently pulling them. Loosen all six head harness straps in this manner, leaving only about an inch of strap still threaded in the buckles. Put facepiece on with straps loose, and hold firmly against the chin with one hand. Center the headpad on the back of the head. Adjust the middle pair of straps, one at a time, by tightening evenly until the buckle lies flat. The ends of the straps should be about the same length. Adjust the top pair, and then in the like manner the bottom pair to the same tension as the middle pair of straps. Check mask to test for fit. If the mask does not fit, the top pair may be drawn up a bit tighter after smoothing mask to the face from bottom to top, or if the individual has prominent hollows at the temple, the middle pair may need further adjustment.

If the facepiece allows air to enter at this time, two possible faults are indicated:

1. If the leakage is noticed between the edges of the facepiece and the face, faulty adjustment and fitting are probable. Such a fault may be overcome by pressing the edges of the facepiece to the face and readjusting the head harness straps a little at a time. A mask adjusted too tightly may cause a channel at the edge of the facepiece through which the gas may enter. Headache and discomfort on prolonged wearing may also result from wearing a mask that is too tight.

2. If the adjustment of the head harness fails to stop the leak, it is possible that a hole or rip in the hose, outlet valve, or facepiece may have developed, and a minute visual inspection of the gas mask is necessary. If, in order to get proper adjustment, the facepiece is uncomfortably jammed against your face, turn it in and try another mask. Individual masks will vary slightly in size in spite of standard specifications.

VII

DETECTION AND DECONTAMINATION

Detector devices

We have developed various detector devices which tell us whether gases are present which must be decontaminated, and after decontamination, whether we have done a good job and gotten rid of all the chemical agent. These detector devices are much more reliable than your nose, which, as you know, is the most common detector agency.

Vesicant (blister gas) detector paint, M5, is olive green in color and may be applied to surfaces likely to be exposed to chemical warfare attack. The green color of the paint turns red when *liquid* blister gases touch it. *It gives no reaction to blister gas vapors.* In addition to blister gases, some decontaminants also turn the paint red. Therefore, the paint is useful mainly as a warning device, rather than a testing device after decontamination of an area has taken place.

Vesicant (blister gas) detector paper, M6, reacts exactly the same as the detector paint. Squares of the paper are secured coated side up, preferably on a horizontal surface fully exposed to blister gas spray. It may also be used in testing areas thought to be contaminated with a *liquid* blister gas.

Vesicant (blister gas) crayon, M7, comes in sticks looking like pink blackboard chalk. The pink color turns to bright blue in contact with liquid mustard, Lewisite, ethyldichlorarsine, or *high* vapor concentrations of these agents. Detailed instructions for use come with each box of 12 crayons, but briefly, the crayon may be powdered with a knife and dusted over the suspected surface, it may be drawn across the suspected surface, or a piece of white paper may be coated on one side with the crayon and the coated side of the paper then held against the suspected surface. This crayon is useful for testing the effectiveness of decontamination jobs as well as testing whether an area needs decontamination. It should be noted that this crayon does *not* react with the nitrogen mustard gases.

Detector kits.—Much more sensitive than the paint, paper or crayon just mentioned are detector kits. There are several types of these kits. The Navy Gas Detector Kit, Mark 1, and the Army Chemical Agent Detector Kit, M9, will detect dangerous concentrations of the vapors of

most of the important war gases. The Army Mustard Vapor Detector Kit, M4, provides a test for mustard and the nitrogen mustards. These kits are rather tricky to use but they are indispensable in detecting low concentrations of vapor, and to decontamination squads who must be sure that their decontaminating work has been thoroughly effective in removing all traces of a chemical warfare agent. Detailed instructions for use are provided with each kit.

General discussion of decontamination

Decontamination is the term applied to the process of removing or destroying chemical warfare agents which have contaminated either personnel or matériel. This short discussion is designed to present to you the basic principles of both ship and shore decontamination.

A ship is a compact fighting unit, and almost every part of it is a vital area. A section cannot generally be evacuated as is possible in the case of a shore establishment. The men must continue to sleep, eat and fight on the ship, so decontamination must be begun as soon as the tactical situation permits, and carried to completion as rapidly as possible.

For decontamination work, we must have special agents. They must be agents which can be stowed for considerable lengths of time aboard ship without decomposing under the conditions that may be expected there. They must also be noncorrosive as there is a great deal of relatively sensitive matériel aboard which would be ruined by rusting. Chloride of lime, a common decontaminating agent ashore, fails for use at sea, as it deteriorates on storage and has a bad effect both on metals and clothing.

Decontamination procedure for blister gases

Our primary interest in regard to decontamination is the procedure for blister gases. They are the most insidious of the known agents. The mustards in liquid form penetrate rapidly into ordinary clothing, paintwork, wood, canvas, and practically all materials and surfaces, except unpainted metal and glass, and are capable of producing casualties for a long period of time.

Decontamination of ships

Based on the requirements of stable stowage at sea and noncorrosive action upon matériel, the Navy has selected as the active agent for decontamination aboard ship, RH–195. It is a light cream-colored powder which releases active chlorine on contact with mustard or other blister gases and thereby neutralizes them.

To dissolve and spread the RH–195, which is not soluble in water, a solvent known as tetrachlorethane (acetylene tetrachloride or TCE) is provided. This solvent is a colorless liquid which is stable for

indefinite periods. It is noninflammable, but gives off dangerous fumes which, if inhaled to any great extent, are poisonous. Continuous physical contact with the solvent (either inhalation of the fumes or physical contact with the liquid), produces a cumulative toxic effect on the internal organs. However, the gas mask gives complete protection against the fumes, and if the hands are protected against contact with the liquid by wearing rubber gloves, there should be no difficulty encountered in the handling of this liquid.

The RH–195 solution is made up by mixing 1 part of the RH–195 with 4 parts of the solvent by *volume*, or 1 part to 10 by *weight*. In other words, one glass jar of the RH–195 powder should be mixed with four 5-gallon drums of the liquid TCE if mixing large quantities. It should be mixed topsides in any *dry* metal drum or container and should be stirred for at least 5 minutes. If it is to be applied by spraying, the solution should be poured through two thicknesses of cheesecloth or a strainer of similar mesh.

Application.—One gallon of this solution will effectively decontaminate 15 square yards of heavily contaminated area, 30 square yards of moderately contaminated area, and a larger area which has been lightly contaminated.

Hand pumps of 3-gallon capacity are issued, by means of which the decontaminating solution may be applied. These are especially intended to apply the solution to the superstructure. The solution can be just as easily applied to other areas by brooms or ki-yis, using an ordinary pail for a container.

Decontamination squads must always be equipped with full protective clothing and masks, and follow the prescribed procedure for donning the clothing, and after the decontamination work is done, in removing it.

In decontamination work, always start at the upper edge of a vertical surface and work downward so that the full benefit of any run-off may be obtained. The work should always start at the edges of the contaminated areas either vertical or flat, and progress in orderly line into the contaminated area, leaving a clean area behind. This is done in order to avoid the risk of contaminating the working party. As applied, the solution should be thoroughly scrubbed in with brooms or ki-yis in order that the solution be brought into intimate contact with the agent. The area should be given several light applications of the RH–195 solution at 10-minute intervals until the required amount has been applied. After the area has been so treated, it should be washed down with the hose to get rid of the decontamination agent. Work should proceed from the windward side, if possible.

The order in decontamination procedure will differ depending on the type of ship, its organization, and the extent of the contamination. Among the important items that must be taken care of first are the following:

1. *Ordnance equipment*—particularly antiaircraft batteries.
2. *Navigation equipment*—everything necessary for the safe handling of the ship.
3. *Vital topside areas*—such as the bridge, lookout stations and areas which must necessarily be occupied.

Decontamination ashore

A shore station is much more vulnerable to chemical attack than a ship at sea. The plan for decontamination will differ greatly, of course, depending upon the location and function of the activity. In general, a shore base is fortunate in that it is possible to evacuate heavily contaminated areas if they are not immediately needed. However, provisions must be made to clean up large areas of a vital nature, such as control centers, gas cleansing stations, roadways, runways, etc.

When it comes to the cleaning up of large areas where corrosion is not a problem, such as land areas and wooden structures on shore stations, bleach (chloride of lime) is usually used rather than the RH–195 solution. This bleach may be used in either of three forms. The first is dry mix. This means that the lime is mixed with earth in the proportion of two parts of lime to three parts of earth by volume, and spread over the contaminated surface and left there for a period of at least 24 hours.

A quicker and more effective means of using this bleach is in a slurry made up of 50 percent bleach, and 50 percent water by weight. For large areas this material is spread by use of a mobile decontaminating unit. One such unit consists of a 400-gallon apparatus mounted on a 2½-ton truck. It is equipped with a wooden tank and the necessary pump and lines to supply the slurry at the rate of 20 gallons per minute at a working pressure of 400 pounds per square inch to the nozzles. The men manning the nozzles can ride on the forward part of the truck and spray a pathway in front of them approximately 13 feet wide and a quarter of a mile long in about 18 minutes.

There is also a smaller unit of 150-gallon capacity. It is capable of pumping 10 gallons per minute at 400 p. s. i. pressure and has one nozzle. It is very mobile, being mounted on a two-wheel trailer which can be towed by a jeep. A gasoline engine attached furnishes the power for the pump. The Navy favors this 150-gallon unit over the 400-gallon one because of its maneuverability.

For small areas a 3-gallon hand sprayer is furnished for use with slurry or RH–195 solution. A 1½-quart apparatus resembling a fire extinguisher is also supplied for applying RH–195 solution. As at sea, the decontamination squads must be equipped with full protective clothing and masks, and the same precautions must be taken to avoid spreading contamination.

Decontamination procedure for other agents.

The wind at sea sweeps away most agents other than blister gases so they present a very small problem insofar as decontamination is concerned. If by chance they should get below decks, personnel must resort to the gas mask until sufficient ventilation can be provided to carry away the vapors.

Procedure against the tear gases

The effects of tear gases will extend over a long period if they are present in liquid or solid form. Therefore it is necessary to have a special procedure to deal with these gases.

Ventilation.—Proper ventilation, involving large quantities of air, can be depended upon to remove CN in the *gaseous* form from interior compartments in a few hours.

Flooding.—If tear gas is sprayed on the ship, the concentration on the weather decks can be temporarily greatly reduced by prompt hosing. The water does not destroy the CN, but the hosing mechanically washes away a large percentage, and the film of water over the CN prevents the air from reaching it and thereby prevents its vaporizing. However, after a contaminated area has been so treated and allowed to dry, there usually is enough CN left to set up a lacrimatory concentration. Therefore, hosing is at the most a temporary measure.

Conclusion

In the time available it has been possible merely to outline the principles and procedures involved. One thing to remember is that to be effective, decontamination must be complete. In other words, all traces of the war gas must be removed. Therefore, it is standard practice after each decontamination operation to check the area involved with one of the detector devices. Decontamination by trained men will allow any ship or station to return to its maximum fighting efficiency in the shortest possible time and with a minimum of casualties.

DECONTAMINATING AGENTS

	Dry mix		Paste		Slurry		Noncorrosive	
Materials	Bleach	Dirt	Bleach	Water	Bleach	Water	RH–195	Tetrachlorethane (TCE).
Parts by weight	1	3	Mix to thin paste		1	1	1	10.
Parts by volume	2 shovels	3 shovels			5 shovels	1 pail (3 gals.).	1 qt. powder.	4 qts. of TCE.
							1 25-lb. jar.	4 drums TCE.
Area covered	5 shovels of mix to 10 sq. yds.		1 sq. yd. per lb. bleach		(1)		30 sq. yds. per gallon for medium contamination.	
Use	Shell holes, open ground, shoes.		Walls, floors, concrete rds.		Bldgs., rds., runways.		Metal surfaces where bleach will corrode. Only agent used on board ships.	
							Do not use on plastics such as airplane cockpit covers.	

[1] Concrete or smooth macadam road.. 1 gal.
Rough macadam or gravel road..... 2 gal.
Short grass..... 3 gal.
Long grass or light brush..... 4–5 gal.
} Per 10 sq. yds.

For EMERGENCY DECONTAMINATION of weapons, personal equipment, use S–461 or S–330 Ointment.

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